

# MEMORANDUM

To: Ken Merrill  
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From: Joel Massmann, Ph.D., P.E.

Date: July 31, 2012

Subject: Clarifications regarding temperature violations and heat flow in the  
Pend Oreille River at the Idaho/Washington state line

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This memorandum is intended to clarify issues regarding temperature violations and heat flow in the Pend Oreille River at the Idaho/Washington state line. Questions were raised during the meeting with EPA on July 24, 2012 related to the temperature conditions for the existing and natural scenarios used in the Pend Oreille temperature TMDL. The clarifications and discussions provided below address those questions.

The discussions below are based on the results of temperature modeling that has been completed as part of the Pend Oreille River temperature TMDL (Baldwin et al., 2011) and on my analyses of those modeling results. These analyses have been described in previous memoranda (Keta Waters, 2009; 2010, 2011; 2012a, 2012b).

## A. Temperature violations at the Idaho/Washington state line

One of the questions raised in the July 24, 2012 meeting was whether there are temperature violations at the Idaho/Washington state line under existing conditions. I indicated during the meeting that there were no violations at the state line, based on the results of temperature modeling that was completed for the Pend Oreille TMDL.

I had interpreted the question as relating to the Kalispel Tribe's criteria. There are no violations of the Kalispel temperature criteria at the state line. However, there are three violations of the State of Washington's temperature criteria at the state line, using the direct pair-wise comparison approach. These violations occur on August 26, 27, and 28. The maximum violation is 0.55 degree and the average violation is 0.26. The violations are summarized in Table 1 below.

**Table 1.** Violations of the State of Washington’s temperature criteria at the Idaho/Washington state line, using the pair-wise comparison approach. All values are degrees Celsius.

Date	Existing condition temperature	Natural condition temperature	Increase in existing condition	Allowable increase	Temperature violation
08/26/04	21.63	21.20	0.44	0.30	0.13
08/27/04	21.50	20.65	0.85	0.30	0.55
08/28/04	21.08	20.70	0.38	0.30	0.08

The Idaho/Washington state line occurs at river mile (RM) 88. This location represents the upstream boundary of the “Newport Reach” as defined by the Department of Ecology in their 2011 TMDL (Table 5, p. 28, Baldwin et al., 2011). Ecology concludes, based on their cumulative frequency distribution approach, that there are no violations of the State of Washington’s temperature criteria within the Newport Reach (Table 6, p. 41, Baldwin et al., 2011). This conclusion is an artifact of the cumulative frequency distribution approach. A direct comparison of daily maximum temperatures under existing and natural conditions shows that violations of the State’s temperature criteria do occur at the state line and in the Newport Reach, as noted in Table 1 above.

#### B. Heat flow in the Pend Oreille River at the Idaho/Washington state line

Ecology has concluded that water flowing from Idaho across the Idaho/Washington Stateline is cooler under existing conditions than under natural conditions (Baldwin et al., 2011, page 73-74). This conclusion is apparently a result of using the cumulative frequency distribution approach with daily maximum temperatures and does not consider specific time periods during the summer months when the water flowing across the state line is warmer under existing conditions as compared to natural conditions. Evaluations described in previous memoranda (Keta Waters, August 2010; June 2011) and summarized below show that the heat load across the Idaho/Washington state line is higher under existing conditions on most days when there are violations at the Kalispel Reservation.

The cumulative frequency distribution approach used by the Department of Ecology is inappropriate for evaluating heat load across the state line from Idaho into Washington for at least two reasons. First, the approach considers only daily maximum temperatures and does not consider the full suite of temperatures that occur throughout a daily heating and cooling cycle. The total heat load across the state line is determined by the full range of temperatures that occur throughout a given day and not just by the maximum daily temperatures. Second, the cumulative frequency distribution approach averages the daily maximum temperatures over a seasonal time period. Individual weeks or months within that seasonal time period that are warmer under existing temperatures are “averaged out” because of the seasonal pooling period adopted by Ecology in applying their cumulative frequency distribution approach. The results of the computer

simulations developed for the TMDL show that heat flow across the state line is greater under existing conditions on most days when the Kalispel temperature criteria are violated (Keta Waters, August 2010; June 2011). The increased heat load from Idaho into Washington that occurs under existing conditions contributes to temperature violations that occur at the Kalispel Reservation.

Figure 1 presents modeling results for existing and natural conditions at the Idaho/Washington state line during the summer of 2004. This graph shows that there are two primary temperature differences between existing and natural conditions at the state line: 1) there are larger daily fluctuations under natural conditions (i.e., the maximum temperatures are higher and the minimum temperatures are lower under natural conditions), and 2) there are higher temperatures throughout the day under existing conditions for some days in late August and early September. The temperatures shown in Figure 1 are the flow-averaged temperatures provided by the Department of Ecology. These are the appropriate and correct values for estimating heat flow across the state line.

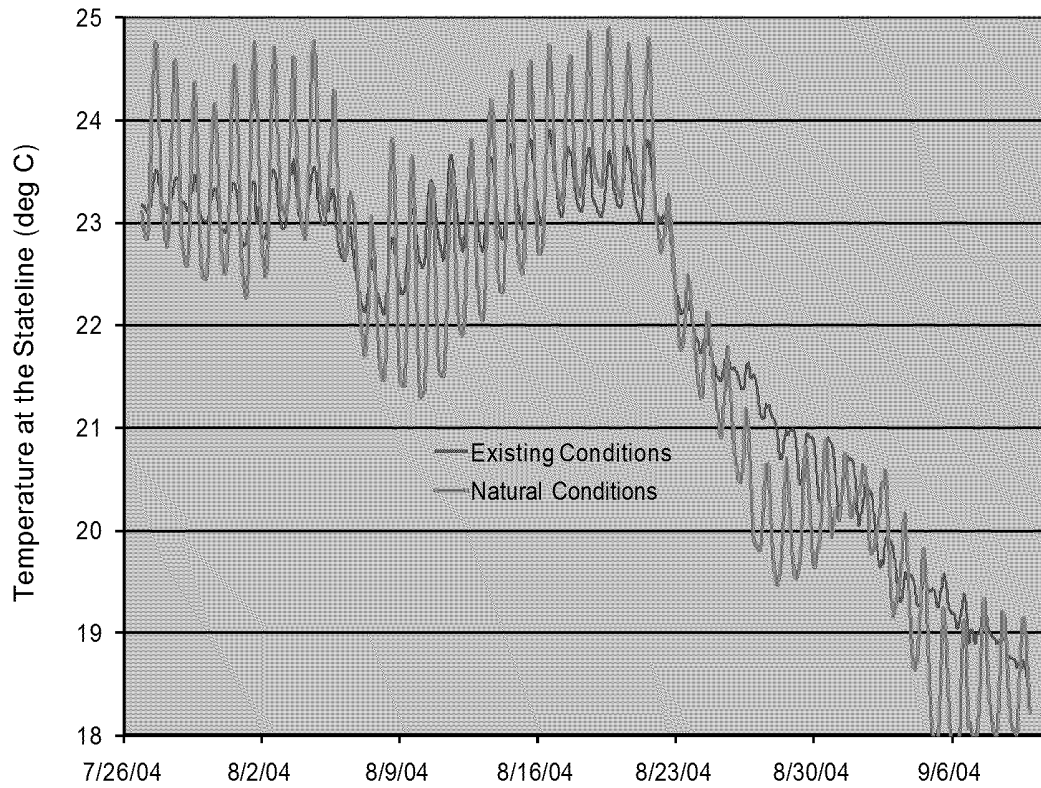
Inspection of Figure 1 shows that whether temperatures are warmer under natural or existing conditions depends upon the period of interest. This is quantified in Table 2 below, which gives the average temperature under existing and natural conditions for a month-long and a week-long averaging period.<sup>1</sup> If temperatures are averaged over the month of August, or over the third week in August, then existing temperatures are warmer than natural temperatures. Table 3 below, which is reproduced from Keta Waters (2012b), shows that most of the violations of the Kalispel Tribe's temperature criteria occur during August and early September. The temperatures and heat flow across the state line are usually greater under existing conditions than under natural conditions during these periods.

Ecology assumes that in the future river temperatures will be cooler than under natural conditions. According to Ecology, this "stateline assumption" provides a baseline for establishing load allocations downstream (Baldwin et al., 2011, page 73). Ecology provides a 0.3 degree C allocation in heat load to the river downstream of the Stateline as a result of their conclusion that water flowing from Idaho is cooler under existing conditions (Baldwin et al., 2011, page 79).

A 0.3 degree C heat load allocation downstream of the Stateline will allow even higher temperatures for those portions of the Pend Oreille River that are within the Tribe's territorial jurisdiction. These higher temperatures will increase the frequency and magnitude of violations of the Kalispel Tribe's temperature criteria.

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<sup>1</sup> The average temperatures included in Table 2 were calculated directly from the model output. This output includes temperature values generated at 28-minute time intervals. The full suite of modeled temperatures (i.e., 50 temperatures per day) was included in calculating temperature averages. Using the full suite of temperatures, and not just daily maximums, is the correct and appropriate approach for comparing heat loads under natural and existing conditions.



**Figure 1.** Temperatures at the state line under existing and natural conditions as predicted using the Box Canyon model

**Table 2.** Average temperature at the state line under existing and natural conditions for several averaging periods

Beginning date	End date	Average temperature for existing conditions	Average temperature for natural conditions	Difference	Conclusion
8/01/04	8/31/04	22.56	22.46	+0.10	Existing is warmer
8/23/04	8/30/04	21.32	20.74	+0.58	Existing is warmer

**Table 3.** Violations of the Kalispel Tribe's temperature criteria. All values are deg C.

Date	Type of Violation <sup>1</sup>	Location of Violation	Magnitude of Violation	Temperature under existing conditions		Warming between RM 88 and RM 72
				RM88	RM72	
06/29/04	Type 3	RM 64	0.40	19.53	20.23	0.70
06/30/04	Type 3	RM 66	1.41	18.66	20.03	1.38
07/10/04	Type 3	RM 72	0.44	20.60	20.66	0.06
07/11/04	Type 3	RM 72	0.50	20.41	20.77	0.36
07/18/04	Type 4	RM 64	0.01	21.53	22.79	1.26
07/27/04	Type 4	RM 72	0.17	23.51	24.59	1.08
07/28/04	Type 2	RM 72	0.04	23.44	24.38	0.95
07/29/04	Type 4	RM 72	0.06	23.47	24.49	1.02
07/30/04	Type 4	RM 72	0.58	23.34	24.50	1.16
07/31/04	Type 4	RM 72	0.19	23.40	24.47	1.07
08/04/04	Type 4	RM 64	0.10	23.55	24.42	0.87
08/09/04	Type 2	RM 72	0.05	23.15	23.72	0.57
08/10/04	Type 4	RM 72	0.24	23.43	24.10	0.67
08/11/04	Type 4	RM 72	0.69	23.68	24.56	0.88
08/12/04	Type 4	RM 72	0.80	23.61	24.81	1.20
08/13/04	Type 4	RM 64	0.68	23.65	24.80	1.15
08/14/04	Type 4	RM 64	0.65	23.79	24.87	1.08
08/15/04	Type 4	RM 64	0.61	23.83	25.01	1.18
08/16/04	Type 4	RM 64	0.59	23.92	25.10	1.18
08/17/04	Type 4	RM 64	0.02	23.74	24.83	1.09
08/18/04	Type 4	RM 64	0.09	23.74	24.76	1.02
08/21/04	Type 4	RM 64	0.35	23.81	24.27	0.45
08/23/04	Type 4	RM 72	0.21	22.38	22.29	-0.10
08/25/04	Type 2	RM 72	0.13	21.78	21.10	-0.69
08/26/04	Type 2	RM 72	0.29	21.63	21.42	-0.21
08/27/04	Type 3	RM 72	0.84	21.50	21.33	-0.18
08/28/04	Type 3	RM 72	1.08	21.08	21.22	0.14
08/29/04	Type 3	RM 72	1.03	20.97	21.24	0.26
08/30/04	Type 3	RM 64	0.94	20.90	21.23	0.33
08/31/04	Type 3	RM 64	1.06	20.75	21.26	0.51
09/01/04	Type 3	RM 64	0.74	20.65	20.78	0.13
09/04/04	Type 2	RM 72	0.04	19.55	19.54	-0.01
09/05/04	Type 2	RM 72	0.15	19.58	19.75	0.17
09/06/04	Type 2	RM 72	0.26	19.38	19.82	0.44
09/07/04	Type 2	RM 72	0.35	19.27	19.45	0.18
09/08/04	Type 2	RM 72	0.31	19.01	19.72	0.71
09/09/04	Type 2	RM 72	0.16	18.76	19.21	0.46
Average violation:			0.44			
Maximum violation:			1.41			

<sup>1</sup>Type 1: natural 7-DADMax ≤ 18°C, and existing 7-DADMax > 18°C;

Type 2: natural 7-DADMax &gt; 18°C, and existing 7-DADMax &gt; natural 7-DADMax + 0.3°C;

Type 3: natural 1-DMax ≤ 20.5°C, and existing 1-DMax &gt; 20.5°C; or

Type 4: natural 1-DMax &gt; 20.5°C, and existing 1-DMax &gt; natural 1-DMax + 0.3°C.

## **References**

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- Keta Waters. 2009. *Review of temperature modeling, Pend Oreille River*, June 16, 2009 memorandum to Ken Merrill, Water Resources Manager, Kalispel Tribe Natural Resources Department.
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